PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

Fourth Series

Vol. XXV, No. 16, pp. 377–420, pls. 37–46 November 15, 1946

ALICE EASTWOOD
SEMI-CENTENNIAL PUBLICATIONS

No. 16

ENDEMISM IN THE HAWAIIAN FLORA, AND A REVISION OF THE HAWAIIAN SPECIES OF GUNNERA (HALORAGIDACEAE) HAWAIIAN PLANT STUDIES 11[1]

BY

HAROLD ST. JOHN
Professor of Botany, University of Hawaii

ENDEMISM IN THE HAWAIIAN FLORA

Endemism in its flora has long made the plants of the Hawaiian Islands famous. Of the islands or floristic regions of the world having a flora of more than a few species, they are said to have the world's largest percentage of endemics.

Prof. A. Guillaumin (Proc. 3rd. Pan. Pacif. Sci. Congr. Tokyo 1 : 930, 1926) in his review of the Pacific island floras calculates that endemism for the Hawaiian Phanerogams is 66 per cent. He does not state how he arrived at this figure but his totals of the species are evidently those of Wm. Hillebrand. This early botanist, Hillebrand (Fl. Hawaiian Ids. p. XVII, 1888), calculated that of the native Phanerogams, 574 were endemic, while 246 only were indigenous, and 24 of early aboriginal introduction, and the total of native Phanerogams and Vascular Cryptogams was 860. It is apparent that Guillaumin used this total of 860 indigenous Vascular Plants and Hillebrand's figure of 574 indigenous Phanerogams in computing the percentage of en-

[1] This is the eleventh of a series of papers designed to present descriptions, revisions, and records of Hawaiian plants. The preceding papers have been published as Occasional Papers Bishop Museum 10(4), 1933; 10(12), 1934; 11(14), 1935; 12(8), 1936; 14(8), 1938; 15(1), 1939; 15(2), 1939; 15(22), 1940; 15(28), 1940; 17(12), 1943; Lloydia 7:265–274, 1944; Bull. Torrey Bot. Club 72:22–30, 1945.

demism, which he calculated as 66 per cent. Had he used 705 native species and 574 endemics, which are Hillebrand's truly comparable figures for the Phanerogams, the endemism would figure out as 81 per cent, which was the estimate of Hillebrand, previous to his death in 1886. All species published since that date or unknown to Hillebrand, Guillaumin seems to reject by his phrase that the area presents an extraordinary number of varieties which are sometimes considered as species of narrow geographic localization ("présente un nombre extraordinaire de variétés, considérées parfois des comme espèces et étroitement localisées."). D. H. Campbell used the same figures from Hillebrand, but he correctly calculated the endemism of Phanerograms as 81.42 per cent (The Derivation of the Flora of Hawaii, Univ. Ser. Stanford Univ., Publ. 15, 1919). Also R. Kanehira apparently used the same figures as he lists the Hawaiian endemism as 81 per cent (Proc. 6th Pacif. Sci. Congr. 4:610, 1940). Guillaumin concludes (pp. 921, 931) that in the Hawaiian flora the Australian, New Zealand, and even Polynesian elements are almost completely lacking, that the flora has strong relationships with the American flora and should be considered a part of the Mexican floristic region. The present writer disputes all of these conclusions of Guillaumin.

The interpretations of C. Skottsberg seem more truly in accord with the facts. He divided the Hawaiian species of Phanerogams (Bull. Bishop Mus. 16:6, 1925) as 32.3 per cent Old-Pacific; 29 per cent Australian-Polynesian; 26.5 per cent Indo-Malayan; 7.5 per cent American; 3.3 per cent widespread; 1.2 per cent Subantarctic; and 0.2 per cent Boreal. The widespread or Pantropic and the Subantarctic may well have immigrated by the same route as the other groups from Oceania. If these, then, are all added, the total is 92.3 per cent for the plants with a probable southwestern origin that came or whose ancestors came as a stream of plant immigrants through Polynesia. Later Skottsberg discusses the genera (Proc. Linn. Soc. 151:182–186, 1939), their relationship, and probable route of immigration. Of more than 200 genera, 18 are Pantropic, 15 Paleotropic, 49 Malesian, 12 littoral are widespread, 57 Austral, 22 Boreal, 9 aquatics apparently Boreal, and 13 Neotropical. This review of the Hawaiian genera gives the same picture as with the species: a large majority Indo-Malayan or Polynesian, small minorities Boreal and American.

The same early source, Hillebrand, was used by J. C. Willis (Proc. Linn. Soc. London 148:86–91, 1936) in his contemporary discussion of regional endemism. Hillebrand's figures should not be discounted. They were based on his excellent flora and were correct for his time, that is 58 years ago. Still, to discuss the endemism of the Hawaiian flora today and to use only Hillebrand's figures is not the modern scientific method, which should use all available evidence. Since 1886 in Hawaii there has been a great deal of arduous exploration of the rain forests and the precipitous mountains. Here and elsewhere a large amount of floristic and monographic work has been published. To overlook and reject all the work of C. B. Clarke, Heller, Rock, C. N. Forbes,

Beccari, Léveillé, Skottsberg, Christensen, Degener, St. John, Sherff, Yuncker, Christophersen, Caum, Hitchcock, Hochreutiner, Pilger, von Poellnitz, Radlkofer, Oliver, Danser, Heimerl, Keck, Krajina, Whitney, Hosaka, Fosberg, Egler, Lam, Croizat, Sleumer, and others, is not the way to arrive at a modern estimate of the known Hawaiian flora. Skottsberg used the more sound method of including subsequent publications (Bull. Bishop Mus. 16:5, 1925) when he gave a tentative estimate of the indigenous Hawaiian Phanerogams as about 900 species. Later he revised this figure to between 1,000 and 1,100 (Proc. 6th Pacif. Sci. Congr. Berkeley 4: 685, 1940). The writer keeps a check list of the Hawaiian flora. There are quite a number of the recently proposed segregate species which he has not included, awaiting time to verify their status, but many will doubtless be accepted. When eventually added in, they will increase rather than diminish the percentage of endemism. At present the writer's figures for endemism of Hawaiian Phanerogams is 90 per cent, based on totals of 1795 indigenous, and 1614 endemic species and their subdivisions. Estimates by some others exclude all subdivisions of species, but here each is included as a unit.

Some Hawaiian genera contain species that are homogeneous and widespread, occurring unmodified on all or nearly all of the large islands. Examples are given in the two following lists.

I. Homogeneous Widespread Species in Genera Monotypic in the Hawaiian Islands

Freycinetia arborea Gaud.
Joinvillea Gaudichaudiana Brogn. and Gris
Dianella sandwicensis H. and A.[2]
Anoectochilus sandwicensis Lindl.
Liparis hawaiiensis Mann
Habenaria holochila Hbd.
Pilea peploides H. and A.
Argemone alba Lestib. var. *glauca* Prain
Osteomeles anthyllidifolia Lindl.
Erythrina sandwicensis Degener
Strongylodon lucidus Seem.
Plumbago zeylanica L.
Osmanthus sandwicensis (Gray) B. and H.
Nertera depressa Banks and Soland.

II. Homogeneous Widespread Species in Genera with Several Hawaiian Species

Smilax sandwicensis Kunth
Chenopodium oahuense (Meyen) Aellen[3]
Peperomia leptostachya H. and A.

There are other Hawaiian species widespread among the larger islands, but which are not homogeneous, having a tendency to vary. These variations are in part recognized as described varieties but in large part are unrecognized,

[2] The recently described *Dianella lavarum* Degener and *D. multipedicellata* Degener are considered exact synonyms.

[3] *Chenopodium sandwicheum* Moq. forma *macrospermum* Aellen and forma *microspermum* Aellen are not separable, as the larger and smaller seeds occur on a single plant.

forming a part of the heterogeneous population now included in the species. Such ones are listed below.

III. Polymorphic Widespread Species

Rumex giganteus Ait.
Charpentiera obovata Gaud.
Charpentiera ovata Gaud.
Broussaisia arguta Gaud.
Acacia Koa Gray
Ilex anomala H. and A.
Cheirodendron Gaudichaudii (DC.) Seem.
Vaccinium calycinum Sm.
Vaccinium dentatum Sm.
Styphelia Tameiameiae (Cham.) F. Muell.
Myrsine Lessertiana A.DC.
Gouldia terminalis (H. and A.) Hbd.

Other genera, usually with many species, show a conspicuous segregation into species, usually each species being restricted to a single island or even to a single mountain range or valley on the particular island. Such genera are the following:

IV. Genera with Numerous Species that are Narrow Endemics

Astelia, Schiedea, Pelea, Fagara, Hibiscus, Viola, Labordia, Haplostachys, Phyllostegia, Stenogyne, Cyrtandra, Coprosma, Hedyotis, Clermontia, Cyanea, Delissea, Lobelia, Bidens, Dubautia, and *Lipochaeta.*

The Hawaiian plants here listed illustrate a progressive series: 1, genera monotypic in Hawaii occurring as invariable wides on all the principal islands; 2, species that are invariable wides, belonging to genera with several Hawaiian species; 3, species that are wides, but showing variability on the various islands; and 4, general with many Hawaiian species, typically with different, distinct species on each island. These species represent degrees of increasing differentiation and presumably of decreasing age. They show evidences of speciation. The results of this species formation can be seen in the percentages of endemism here presented and discussed.

REVISION OF THE HAWAIIAN SPECIES OF GUNNERA

One of the most famous of the genera occurring in the Hawaiian Islands is *Gunnera,* called by the natives "apeape." It is a giant herb with a stem 12 to 15 cm. or more in diameter, fleshy, 2 to 6 meters tall, the base decumbent and prostrate. The paired stipules are large, pale, and conspicuous. From near the summit are produced several alternate leaves on fleshy petioles 6 to 13 dm. long. The blades are rounded, shallowly lobed, like great parasols 4 to 20 dm. in diameter. Axillary panicles 8 to 10 dm. long bear numerous minute green flowers and later tiny yellow, orange, red, or purplish drupes. The plant itself is so bizarre as to hold the attention and interest of all observers, whether scientific or not. Thus its occurrence is shown even on the tourist maps.

The habitat of the "apeape" is also noteworthy. It occurs on precipitous slopes with the soil saturated from the run-off of the boggy mountain summits.

It is usually on the face or the foot of a precipice ("pali" in Hawaiian) and is often difficult of access. It forms a definite vegetational belt between the Middle Forest and the Upper Forest, at anywhere from 2,500 to 5,000 feet altitude. Because of the distinctive, giant leaves, this belt of "apeape," though narrow, is often so conspicuous that it can be seen from a distance of two or three miles.

The "apeape" was discovered in 1819 by Charles Gaudichaud, who published it in 1830 as *Gunnera petaloïdea*. Subsequent collections have revealed that *Gunnera* occurs on Kauai, Oahu, Molokai, Maui, and Hawaii. Hillebrand interpreted these as different locality records for the single species. This has been the generally accepted view, that the same species occurred on all of the islands.

The taxonomic history since the original publication by Gaudichaud has been brief. Alphonse De Candolle described a specimen collected on Kaui [= Kauai] by the United States Exploring Expedition as *G. petaloidea* Gaud. *β Kauensis* A.DC. (De Candolle, Prodr. Reg. Veg. 16(2) : 597, 1868). His four word description included only two characters, almost glabrous, the bracts shorter. We now find no differences in the Kauai plants in pubescence, and the bracts appear to be alike. This plant was treated later as an unnamed variety, *G. petaloidea* Gaud. *β* (Hillebrand, Fl. Haw. Ids. 124, 1888). In 1930 it was again distinguished by two botanists in almost simultaneous publications. *Gunnera kauaiensis* Rock in Caum (Occ. Pap. B. P. Bishop Mus. 9(5) : 3–4, pl. I, 1930, Sept.). Rock described it from a new type specimen, Rock, 5,053 from Mt. Waialeale. The second author, Krajina, redescribed it as *G. Dominii* Krajina (Acta Bot. Bohemica 9 : 50, ill. p. 51, 1930, without precise date), citing as synonyms the varieties of De Candolle and of Hillebrand, but listing only his own collection from "montis Waialeale." It is apparent from the characters given below that this Kauai plant with peltate blades and red to purplish drupes is a distinct species. Several attempts to learn from Prague the exact month and day of publication of Krajina's paper have failed. A new search is being made for the date. In the meantime, the name given by Rock is accepted as it is dated to the month.

Krajina also described and illustrated from his own collections *G. petaloidea*. He published as two new varieties: var. *kaalensis* (p. 50) from his collection on Puu Kaala, Oahu; and var. *mauiensis* from his collection by Waikamoi Stream, east Maui. Krajina apparently did not examine Gaudichaud's type specimen, nor did he indicate whether or not either of his two varieties was to be considered var. *typica* though with a different name. Duplicates of Krajina's collections have not yet reached the Bishop Museum, nor has the writer seen them in other herbaria. Still, there is no difficulty in matching them. Dr. V. Krajina was a fellow at the Bishop Museum in 1929–30, a keen, energetic botanist who soon became my good friend and I took him on many field trips. His type of var. *kaalensis* was collected on my class trip to Puu Kaala at the well-known locality above the fire-brick trail from Schofield

Barracks. My collection, St. John 10,072, was made at the same spot and time as Krajina's and there are numerous other collections from this locality. His type of var. *mauiensis* was collected at another often visited spot where the Olinda Pipe Line Trail crosses Waikamoi gulch. There are several other collections from the same spot.

That recounts the known taxonomic history of this genus in Hawaii. The plant is known to all collectors and there are several standard, fairly easily accessible localities. The writer has collected it on Kauai, Oahu, Maui, and Hawaii, but any new locality is always noteworthy. On Oahu it has been repeatedly collected on the wet, windward side of Mt. Kaala in the Waianae Mountains. There are two or three collections from the drier, leeward side of the same mountain. Also, Miss Marie Neal of the Bishop Museum tells the writer that she has observed *Gunnera* in the same mountain range on the adjacent peak, Puu Kalena, on its northeast or windward side.

The preferred habitat is steep, water-soaked slopes on the windward side of a mountain range. It has long puzzled the writer that the "apeape" was abundant in the Waianae Mts. and not in the Koolau Range, the more easterly mountain chain on Oahu. The Waianae Mts. are rather arid, lying in the lee of the Koolau Range which gets the impact of the moist northeast trade winds and receives most of their moisture, while but little of it reaches the Waianae Mts. Only the highest peak, Mt. Kaala (called Puu Kaala on the earlier, 1917, official topographic map) gets a considerable rainfall. It is just far enough to the north to receive the impact of the northeast trade winds which sweep over or past the descending, low, north end of the Koolau Range. This is only about 1,000 feet high at this point, not high enough to cause the precipitation of all the moisture. Hence, Mt. Kaala with its large flat summit at 4,025 feet altitude and its upper ridges get enough rainfall to support a luxuriant rain forest. The summit has a swampy forest except for some boggy openings near its center. The average annual rainfall is now known to be 91 inches (Feldwisch, W. E., First Progress Rept., Hawaii Territorial Planning Board 121, 1939).

The Koolau Range, Oahu, running from southeast to northwest, forms the backbone of the eastern side of the island. It rises abruptly close to the shore, and the section above 1,500 feet in height extends for about 25 miles, making a barrier almost exactly at right angles to the prevailing northeast trades. There are numerous sharp peaks that rise from the range, the highest being Puu Konahuanui with twin peaks 3,105 and 3,150 feet high. The several rain gauging stations show a high rainfall, as this mountain range catches much of the moisture from the clouds. The rainfall is more than 100 inches annually for most of this ridge and at the wettest station is 311 inches. There are miles of wind-swept precipices ("pali") and steep slopes with much water seepage from the higher peaks, just the kind of habitat that usually supports *Gunnera*. The writer had botanized these brinks and declivities at many localities along the Koolau Range, and had never found the "apeape." Yet, this *Gunnera* is a plant that one cannot easily overlook. With its bizarre leaves

like huge umbrellas, it is always the biggest and most conspicuous plant in its area. There were no specimens from the Koolau Range in the Bishop Museum, yet the plant has been reported from there. Prof. Vaughan MacCaughey listed it as rare in the rain forests of Manoa Valley (Am. Journ. Bot. 4: 600, 1917). In the same year in a short article about *Gunnera petaloidea* (Am. Journ. Bot. 4: 38, 1917, the reprints incorrectly printed vol. 1) he stated that among its typical habitats were "Ka-ala and Kona-hua-nui summit ridges on Oahu (2,500–4,000 ft.)." The 4,000 foot record is certainly that for the often visited station of Mt. Kaala in the Waianae Mts. Hence, we infer that his station on the 3,150 foot peak Puu Konahuanui was at about 2,500 feet altitude. MacCaughey did exploring and original research in Manoa Valley which heads on the slope of Puu Konahuanui. The plant is unmistakable, so there would seem no reason to question this record, yet corroborating specimens were much to be desired.

Some years ago the writer had an enterprising young man as a student, John R. Coleman. He was enlisted in the United States Marine Corps and was stationed in Honolulu with a company doing guard duty at the docks. At his request he was given continuous and regular night guard duty. This left his day time free and enabled him to attend the University of Hawaii. It was not obvious when he slept, but he did not sleep in class. He completed the course on elementary botany and on week ends he often joined advanced classes on collecting trips to the mountains. One Sunday he induced two other marines to join him, and from Nuuanu Pali they started to climb the knife-edged ridge that culminates in Puu Konahuanui. As he led the way and scrambled up one precipitous slope, the bushes, soil, and all caved away. He managed to make headway over the landslide and surmounted the ledge. All the footholds were destroyed, so his companions could not follow, and turned back. Coleman went on, climbed to the summit, and descended by a more southerly route. The next day he brought me a 10 cm. tip from a fruiting inflorescence with half ripe drupes, of a specimen that seemed to be *Gunnera*. He reported collecting it near the summit on Oct. 19, 1930. This specimen gave partial proof of the occurrence in the Koolau Range, but it was incomplete. At last, in June 1942 the proof was furnished by two students, L. Eubank and A. D. Conger, who, on a wet day amid swirling clouds and rain, ascended Puu Konahuanui. They observed and collected abundant and complete material. They reported the three small colonies to be on the Manoa or leeward slope. A second visit on Sept. 13, 1942 by A. D. Conger, H. St. John, and R. P. St. John was also in the clouds and intermittent rain, but thrice the clouds lifted to reveal the slopes, valleys and the shore line. All three patches proved to be on the windward or Kailua side. Any mountaineer will understand how in following forking, intricate ridges in dense clouds, one can lose track of the directions. One locality was a single plant some 250 feet below the lower or south peak which is mapped and triangulated as Puu Konahuanui. The two others were on the east face of a northeast ridge of the north or higher peak. There were numerous plants in

a steep, brushy, hanging valley at 2,950 feet altitude. Though both Miss Eubank and Mr. Conger previously slid down the cloud-blanketed slope to the plants, then scrambled up again, on the second trip no one wanted to try it again. It was very dangerous, and when clear of clouds it was obvious that an uncontrolled slip on the steep, slippery clay would give one a flying start over the 1,000 foot precipice. Later a fourth colony was located. On May 9, 1943 the writer conducted a student party of nine from Tantalus to the summit of Puu Konahuanui. Clouds blanketed the precipices on the east slope hiding the single plant on the South Peak. From the North Peak a descent was made down the secondary ridge towards Kailua. The middle and inaccessible colony of *Gunnera* was again seen far below in the cloud. Neither the writer nor his son Robert could locate the third colony, though this time a rope was at hand for a descent to it. The clouds hid it completely. Climbing up again, the descent was made along the main divide to the road at Nuuanu Pali. On this divide a new colony was found, also on the east face, in a moist, precipitous, hanging valley at 2,300 feet altitude. By the use of a rope the colony was visited and specimens collected. There were more than 12 plants, up to 4 meters tall, some exposed, others half hidden by the thicket of *Pipturus albidus* and *Cyrtandra paludosa*. The specimens collected have been deposited in the Bishop Museum. These plants from the Koolau Range were critically compared with those from the east side of Mt. Kaala in the Waianae Mts. and were found to be identical in structure and quite inseparable, though the blades are smaller, the length along the midrib not exceeding 4 dm.

While investigating this material the writer took occasion to assemble all available specimens and to evaluate the species and varieties described from the other Hawaiian Islands by Rock and by Krajina. Its massive fleshy stems, giant fruit clusters, and rounded leaves, 1 to 2 meters in diameter, cannot well be compressed upon a standard herbarium sheet, so that the collector is forced to take sample fragments which are inevitably incomplete, and the leaves selected are often the smaller ones. Hence, all taxonomists revising the group and writing descriptions from the available herbarium material present measurements which are true as far as they go, but minimize the size of the giant stems, leaves, and inflorescences. Several of the writer's whole numbers including many unmounted duplicates are available, but still there are gaps. From east Maui there are no mature stipules, and from west Maui there are no petals, and mature drupes and stones are needed from Molokai and from Makaha Valley, Oahu. Still the collections are numerous and have proven sufficient. At a glance they all look alike, but on close study differences are noted in the floral and fruiting morphology. It is curious that most of the characters are minute, a difference in shape to be seen with a lens or in size measured in fractions of a millimeter. Seedlings are often collected. Since they produce smaller stipules and blades that are much smaller and more reniform, they have not been included in our descriptions. The only large parts furnishing characters are the stipules and the leaves as to lobing and toothing and

pubescence. When contrasted throughout, several correlated characters mostly of floral and fruiting anatomy are found. When separated on these characters, the segregates are found to agree in leaf and stipule characters and to have good geographic correlations. Each island has one local kind, except Maui and Oahu which have two each. When evaluated, the number and sort of characters would indicate that these segregates are properly considered species.

The original species was *Gunnera petaloïdea* Gaudichaud (Voy. "Uranie," Bot. 512, 1830). The plant was not illustrated and the 16 word description includes only the major features, but none of the ones now found serviceable in distinguishing the local species. Neither Rock nor Krajina gave any discussion as to the nature of *G. petaloïdea* Gaud. or its type locality. That published by Gaudichaud was "In insulis Sandwicensibus (Alt. 450–500 hex.)." No island is specified, and the statement of altitude in fathoms is unusual, but was perhaps natural after months at sea on a sailing vessel! Search has been made for any detailed itinerary of Gaudichaud. He published none, and the narrative by the commander, Capt. Louis de Freycinet, and those by other members of the expeditions give much on the physique and social habits of the native inhabitants, but nothing on the route of the collecting botanist. On the "Uranie" voyage they spent 20 days in the Hawaiian Islands and Gaudichaud was on shore 7 days. The writer has long marveled at the large number of the endemic species and genera that he collected and described on this first voyage. Starting from the harbor, with no good roads, no cut mountain trails, to get up into the dense, native forests and through them to the cloud zone was a herculean task. Then, over half of his collections were lost when the homeward bound ship was wrecked on the Falkland Islands. All were soaked in sea water, but he rescued many by drying them before a bonfire on the beach. These experiences are mentioned in a few brief words, but what stark tragedy they describe! What a grand naturalist he must have been, yet no portrait of him is known! He did not specify where his shore trips were made, but the ship made landings on Aug. 8, 1819 at Kayakoua [Kailua, Hawaii]; Aug. 12 at Bay of Kohaïhaï [Kawaihae, Hawaii]; Aug. 17–25 at Raheina [Lahaina, Maui]; Aug. 26–30 at d'Onorourou [Honolulu, Oahu]. So the seven days on shore were divided among these localities, but just how is not known. In one day from the arid regions near Kailua and Kawaihae, it would not have been possible to ascend to the habitat of *Gunnera* on the far side of the Kohala Mts. Hence, the island of Hawaii can be eliminated. Back of Lahaina, Maui, the mountains rise abruptly from near the shore, and on the steep upper slopes of the valleys *Gunnera* is abundant. From Honolulu it would have been possible to find *Gunnera* in either mountain range. However, the east cliffs of Mt. Kaala were distant and difficult of access. It is unlikely that he could have gotten there. Puu Konahuanui is only 6 miles in an air line from the harbor of Honolulu. It is known that he climbed to the cloud zone at the crest of the Koolau Range, because he collected *Lobelia Gaudichaudii* which is restricted to that area. Hence, it can be deduced that Gaudichaud probably collected the

Gunnera in the mountains of west Maui or in the Koolau Range near Honolulu, Oahu. In 1935 the writer photographed in Paris Gaudichaud's type specimen of *G. petaloïdea,* reproduced here as Pl. 38. The data on the sheet read "90. Uranie, Ins. Sandwich. C. Gaudichaud." Stipules are lacking and the pieces of the inflorescence do not permit one to detect the minute floral differences from the photograph. However, the margin of the leaf is well shown. The distinct, rounded lobes and the low, rounded teeth or crenations of the leaf margin match exactly those of the species of west Maui, so that it is to be taken as the type locality.

The Hawaiian species all belong to the subgenus *Panke* (Molina) Schindler (Engler, Pflanzenreich IV, fam. 225:117, 1905). This subgenus has a remarkable distribution, occurring also in the Cordilleras from Mexico to Chili, and on Juan Fernandez (Skottsberg, C., Proc. 6th Pacif. Sci. Congr. Berkeley 4: 696, map 14, 1940).

In the ensuing systematic treatment are given key, diagnoses, and descriptions of the species as at present understood.

All the specimens examined and cited and the new types are in the B. P. Bishop Museum, Honolulu, except the Gaudichaud type of *G. petaloïdea* which is in the Museum d'Histoire Naturelle, Paris.

KEY TO THE HAWAIIAN SPECIES OF GUNNERA

Blades peltate; drupes red to purplish ..... 7. *G. kauaiensis* Rock

Blades basifixed; drupes yellow, orange (or reddish in *G. mauiensis*)

- Stipules scurfy on back or finally glabrate,
  - Petals entire, obtuse, glabrous; sepals 0.6–0.8 mm long, rounded, lacerate; anthers 1.2–1.3 mm. long; pedunele bractless except at base; blade margin lacking mueros ..... 5. *G. kaalaensis* (Krajina) St. John.
  - Petals lacerate-fimbriate, often acuminate; sepals 1–1.2 mm. long, broadly deltoid, deeply lacerate; anthers 1.6–2.2 mm. long; pedunele bracted; (stipules apparently scurfy); teeth of blade margin with revolute mueros 6. *G. makahaensis* St. John.
- Stipules not scurfy on the back,
  - Stipules glabrous,
    - Sepals 1.5–2 mm. long, ovate, deeply lacerate, the lacerations fimbriate; petals entire ..... 1. *G. petaloïdea* Gaud.
    - Sepals 0.6–0.8 mm. long, broadly deltoid to rounded, lacerate; petals minutely lacerate ..... 2. *G. molokaiensis* St. John.
  - Stipules pubescent,
    - Petals 1.5 mm. long, entire or somewhat erose; sepals 0.4–0.6 mm. long, semioval, the obtuse tip minutely ciliate; anthers 1.9–2 mm. long, elliptic oblong ..... 3. *G. mauiensis* (Krajina) St. John.
    - Petals 0.8–1 mm. long, sparsely lacerate; sepals 1–1.2 mm long, oblong lanceolate, the tip lacerate; anthers 1.5–1.7 mm. long, oval 4. *G. Eastwoodae* St. John.

1. **Gunnera petaloïdea** Gaudichaud

(Plate 37, fig. d; pls. 38, 39)

Gunnera petaloïdea Gaudichaud, Voy. "Uranie," Bot. 512, 1826 (= 1830).

Giant herb, 1–6 m. tall; stem 2–5 m. long, 15–22 cm. in diameter, fleshy; often long decumbent, the surface with prominent leaf scars and many oval pits from which prop roots develop on older, mostly decumbent parts of the stem; roots reddish, slimy at tip; stipules 5–9 cm. long, oblanceolate, pale, strongly nerved, glabrous; petioles 2–4 dm. long, hirsute, swollen at the base; blades 27–53 cm. long, cordate-reniform, shallowly palmately 9- or 11-lobed, firm chartaceous, dark green, glabrous or nearly so, impressed reticulate nerved, the veins sparsely hirsutulous, below the surface paler green, the veins even to the tertiary ones densely hirsute, the lobes 1.5–6 cm. long, broadly deltoid, the midrib and prominent lateral veins each ending in a prominent deltoid dentation, the margin crenate or low rounded dentate, the sinus broadly V-shaped; inflorescence probably axillary; bracts at base of inflorescence 3–7 cm. long, lanceolate to oblanceolate, like the stipules; peduncle 5–16 cm. long, hirsute, bractless; inflorescence 3–5.5 dm. long, 12–25 cm. in diameter, lanceoloid, hirsute towards the base, more or less glabrous towards the tip, the principal lower bracts 20–28 mm. long, broadly linear, acute, the margin membranous, the lateral branches ascending or diverging, spiciform; flowers perfect, sessile; ovary barrel-shaped; calyx lobes 1.5–2 mm. long, ovate, deeply lacerate, then the lacerations fimbriate; petals 1.5 mm. long, obovate, cucullate, entire, glabrous; the 2 anthers opposite the petals, anthers 1.6–1.9 mm. long, narrowly elliptic-oblong; the 2 stigmas 2 mm. long, terete, densely puberulent throughout; drupes 2.5–3 mm. in diameter, subglobose, greenish-yellow; stone 1.5–1.8 mm. long, 0.9–1.3 mm. wide, 0.9–1 mm. thick, oval in outline, 4-angled, 4-sided, two of the angles prominent, the third less so, and the fourth still weaker and unequal, the stone laterally compressed, the surface dull, pale yellowish brownish.

Type: "In insulis Sandwicensibus (alt. 450–500 hex.)." The type specimen in Paris is labeled "90, Iles Sandwich, C. Gaudichaud." This is illustrated in our Plate 38.

Collections studied, all from western Maui: Eeka [of Hillebrand = Puu Kukui], ex herb. Lydgate, *W. Hillebrand and J. M. Lydgate;* gulch sides by Mt. Kukui, Sept. 24, 1916, *G. C. Munro 426* and *594;* Hanakaoo, shingles the valley sides in places, May 1910, *C. N. Forbes 69.M;* Olowalu Valley, central ridge, far up on the peak, large patches, May 21, 1920, *C. N. Forbes 2,433.M;* without locality, *J. F. Rock and H*[*osmer*] *8215.*

A discussion of the type locality is given in our introduction. Gaudichaud could have discovered *Gunnera* either on Oahu or on western Maui. Neither his publication nor the type specimen in Paris gives any hint as to the island concerned. Luckily there are some differences in leaf shape, and by careful examination of the lobing and dentation of the leaf margin it has been possible to match the type with recent collections from near Lahaina, Maui. Hence,

it is deduced that Gaudichaud collected the type in the mountains back of Lahaina, Maui.

Most previous authors have combined under *G. petaloïdea* all of the Hawaiian specimens. This was due, doubtless in large part, to the fact that few if any of them had sufficient material to allow the recognition of any diagnostic characters between the specimens from the different islands. Consequently, their descriptions are mostly composite ones, so that one cannot now rely upon them. This also applies to the monographic treatment by A. K. Schindler (Engler's Pflanzenreich IV, fam. 225 : 117, fig. 34, 1905). The details that he shows in his figure 34 of the blade, petal, and anther agree with the characters of the common Oahu plant. The entire, broadly triangular calyx lobes are different from any known Hawaiian plant, and it seems that they are incorrectly delineated. He cited one by Gaudichaud and a total of six collections, originating from three islands, so it is quite possible that his drawing was a composite one made from several of these collections. Hence, this Schindler drawing is considered to be in large part one of *G. kaalaensis,* but not fully accurate.

Gaudichaud in 1830, when he described *G. petaloïdea,* in a footnote deprecated his choice of a specific name which alluded to the presence of petals. He had learned meanwhile that some other species of *Gunnera* had petals, but nevertheless he retained the name of *G. petaloïdea* since he had mentioned it already in his introduction (p. 98) printed in 1827.

Most recent botanists have misspelled the named as *G. petaloidea,* but Gaudichaud clearly published it as *G. petaloïdea,* spelling it thus with a diaeresis over the i to indicate a separation of the syllables, and spelling it consistently on two remote pages. This was not an error, but rather his deliberate choice, so we must follow his spelling despite its strange appearance in a latinized name.

2. **Gunnera molokaiensis** St. John, sp. nov.

(Plate 38, fig. e)

Herba gigantea, laminis 43 cm. longis cordato-reniformibus 9-lobatis chartaceis infra pallidioribus nervis reticulatis hirsutulisque, lobis 5–8 cm. longis sinuato-rotundatis denticulatis, inflorescentiis 15–40 cm. longis lanceoloideis, ramulis spicatis, sepalis 0.6–0.8 mm. longis late deltoideis vel rotundatis laceratis, petalis 1.5 mm. longis cucullatis spatulatis minute laceratis vel subintegris, antheris 1.5–1.9 mm. longis ovalibus, fructibus ignotis.

Giant herb ; stipules 2 cm. long, lanceolate, glabrous (?) ; petiole (one seen) 47 cm. long, with scattered dark pustules especially at base, densely hirsute at base, sparsely so to glabrate elsewhere; blade 43 cm. long, apparently cordate-reniform, shallowly palmately 9-lobed, firm, chartaceous, above dark green, the surface and veins remotely hirsutulous to glabrate, below pale green, the prominent reticulate veins all scabrous hirsutulous, the lobes 5–8 cm. long sinuous rounded, the outline ovate, the sinus U-shaped, the margin irregularly rounded denticulate; inflorescence probably axillary; peduncle 7 cm. long (when young), bractless, tomentose towards the base; inflorescence 15–40 cm.

long, 4–15 cm. in diameter, cylindric to lanceoloid, tomentose on the axis and towards the base, glabrate above, the principal lower bracts 8–12 mm. long, linear-spatulate, the margin membranous, the lateral branches ascending, spiciform; flowers perfect, sessile; ovary barrel-shaped, glabrous; calyx lobes 0.6–0.8 mm. long, broadly deltoid to rounded, lacerate; petals 1.5 mm. long, cucullate, spatulate, minutely lacerate or subentire; the 2 anthers opposite the petals, anthers 1.5–1.9 mm. long, oval; stigmas immature; drupes immature.

Type: **Molokai, Pelekunu Pali,** July 12, 1912, *C. N. Forbes 205.Mo.* B. P. Bishop Museum, Honolulu.

Forbes was the only one to bring back *Gunnera* from the remote precipitous, windward brink of the Molokai mountains. His locality was on the old trail which started from Kamalo, ascended the broad ridge to the cabin near Puu Kolekole, then northeastward across the swampy forest and bogs to the divide near Kaunohua at about 4,535 feet altitude, then descended in switchbacks down the steep head wall on the north side. This deeply eroded Pelekunu Valley is a spectacular bit of mountain scenery. The *Gunnera* was probably found just below the windward or northern crest of the divide.

The writer has a record in his field notebook of observing *Gunnera* in Waikolu Valley, the next one to the west. More exactly this was at Hanalilolilo, near the head of the deeply eroded part of the valley. He did not get close enough to collect the specimens.

G. molokaiensis is most closely related to the species of western Maui, *G. petaloïdea* Gaudichaud, which has the blades shallowly lobed, with lobes 1.5–6 cm. long, the margin crenate or low rounded dentate; the main veins beneath densely hirsute; the sepals 1.5–2 mm. long, ovate, deeply lacerate, the lacerations fimbriate; and the petals entire. *G. molokaiensis* has the blades with marked, well rounded lobes, the lobes 5–8 cm. long, the margin irregularly rounded denticulate; the main veins beneath sparsely tomentose to early glabrate; the sepals 0.6–0.8 mm. long, broadly deltoid to rounded, lacerate; and the petals minutely lacerate.

3. **Gunnera mauiensis** (Krajina) St. John, comb. nov.

(Plate 37, fig. g; pl. 40.)

Gunnera petaloidea Gaudichaud var. *mauiensis* Krajina, Acta Botanica Bohemica 9:50, figs. B_2, F_2, I_2, 1 pl. 1930.

Illustrations: by Bonine, in Rock, J. F., Monograph of the Hawaiian Lobelioideae, Mem. Bishop Mus. 7(2): pl. 34, 1919; by Krajina, see above; by Degener, O., Pl. Hawaii Natl. Park, pl. 66, 1930.

Giant herb about 2–3 m. tall; stem about 1–2 m. tall, the tip assurgent, the stem up to 6 m. in length and 15–20 cm. in diameter; bark near apex hirsute, with numerous glabrous, oval pits, where prop roots may later develop; terminal bud completely covered by the numerous imbricate stipules; stipules of seedlings 1.5–2 cm. long, ovate, membranous, strongly nerved, slender hirsute on the back, those of mature leaves 7.5–10 cm. long, elliptic-lanceolate with a broad truncate base, pale greenish, strongly nerved, sparsely puber-

ulous base and tip; petioles 3–10 dm. long, pustulate, densely hirsute at base, sparsely so elsewhere; blades 30–56 cm. long, cordate-reniform, shallowly palmately 7–11-lobed, firm chartaceous, above dark green, remotely hirsutulous, soon glabrate, below pale green, the prominent veins hirsute, the reticulate veinlets hirsutulous, the lobes 2–4 cm. long, low rounded sinuate, the midrib and one or more principal lateral veins ending in low, deltoid dentations, the sinus broad U-shaped, the margin with low broad denticulations; inflorescence supra-axillary; bracts at base of inflorescence 5 cm. long, oblanceolate, membranous, glabrous; peduncle 15–30 cm. long, hirsute, bractless; inflorescence 4.3–10.5 dm. long, 9–24 cm. in diameter, lanceoloid, the axis hirsute, the principal lower bracts linear-spatulate, acute, with membranous margin, the lateral branches ascending, spiciform, hirsute at base, glabrous towards the tip; flowers perfect, sessile; ovary depressed globose; calyx lobes 0.4–0.6 mm. long, semioval, the obtuse tip minutely ciliate; petals 1.5 mm. long, broadly cucullate-spatulate, glabrous, entire or somewhat erose; the 2 anthers 1.9–2 mm. long, elliptic-oblong; the 2 stigmas 2–3 mm. long, densely puberulous; drupes 2.5–3.5 mm. in diameter, globose, pale salmon-red; stone 1.6–1.9 mm. long, 1.4–1.5 mm. wide, 1–1.2 mm. thick, broadly obovate in outline with three prominent angles of which one is lower due to a slight compression of the stone, and a fourth angle more or less developed or wanting, the surface pale yellowish brown, dull. The fresh flowers are rose-magenta.

Type: "Maui: Makawao District ad plurimos rivulos fluminis Waikamoi in declivibus septentrionali-orientalibus montis Haleakala, ca. 1275 m. s. m., legi 15. IV. 1930." *V. Krajina.* Herb. Charles Univ., Prague, not seen.

Collections studied, all from eastern Maui: Olinda, along pipeline from Idlewild for about 7 miles in deep wet ravine, July 16, 1927, *O. Degener and H. Wiebke 3,404;* the same, July 30, 1927, *D. L. Topping*, herb. *Degener 8,185;* and June 19, 1927, *O. Degener and H. Wiebke 2,240, 2,240a, 2,240b;* Kula Pipe Line, 4,000 ft. alt., bank of Waikamoi Stream, Feb. 11, 1930, *H. St. John 10,302;* Waikamoi, rain forest, 4,250 ft., Aug. 14, 1933, *M. Neal and C. Hartt;* Haiku Uka, Waikamoi Gulch, steep side walls, 4,400 ft. alt., Aug. 4, 1943, *H. St. John 20,358.* The foregoing are all from the same station on the pipe line trail east of Olinda. Ukulele, Sept. 4. 1919, *C. N. Forbes 1,255.M;* Haipuaena Stream, sides of wet valley, el. 4,400 ft., Nov. 23, 1927, *G. C. Munro 740;* below Koolau Gap, Haleakala, extremely rainy, wet region, June 17, 1927, *O. Degener 8,184;* Nahiku, Kuhiwa trail, Koolau Forest Reserve, 6,000 ft. alt., wet woods, Jan. 2, 1937, *H. St. John and R. J. Catto 17,935;* Kipahulu Valley, northerly side gulch near head of Oheo Stream, wet thicket, 5,800 ft. alt., Aug. 22, 1945, *H. St. John and A. L. Mitchell 21,104.*

Most of the localities are in one general region, within a few miles of each other. They are on the windward slope of Haleakala between 4,000 and 6,000 feet altitude. Here in the very wet forests are numerous narrow gulches. On their steep, often dripping side walls, the *Gunnera* is abundant.

On the drier southeast side of Haleakala, *Gunnera* was reported in Kipahulu Valley by Mr. David T. Fleming. In the summer of 1945 while exploring Haleakala for the National Park Service, it was possible for the writer to enter this area. The upper section of Kipahulu Valley is well watered and densely forested; and the steep head walls are nearly always blanketed with clouds

and very wet. The stream heads have cut narrow gulches on the precipitous head walls and in these the *Gunnera* occurs from about 4,500 to 6,000 feet altitudes. It was found possible via Wai Anapanapa to approach one locality and get specimens. These plants prove to be conspecific with those of the windward slope of Haleakala.

4. **Gunnera Eastwoodae** St. John, sp. nov.

(Plate 37, fig. f; plate 42)

Herba gigantea 1.5 m. alta, stipulis hispidis, petiolis 45–60 cm. longis, laminis 38–53 cm. longis cordato-reniformibus parve 9-lobatis chartaceis infra pallidioribus nervis reticulatis hirsutulis lobis 8–10 cm. longis rotundatis apice breve acuminato marginibus apiculato-denticulatis, pedunculis 15–20 cm. longis hirsutis, inflorescentiis 37–64 cm. longis lanceoloideis axi primario tomentoso ramulis spicatis, floribus rubris, sepalis 1–1.2 mm. longis oblongo-lanceolatis ad apicem laceratis, petalis 0.8–1 mm. longis obovatis cucullatis laceratis, antheris 1.5–1.7 mm. longis ovalibus, drupis 3.5–4 mm. diametro luteis, pyrena 1.6–1.8 mm. longa 1.4–1.5 mm. lata 1.1–1.2 mm. crassa late ovali-obovoidea tetragona straminea.

Giant herb, 1.5 m. tall; stem stout and fleshy; stipules of seedlings 1.5–2.5 cm. long, oval, erose, membranous, strongly nerved, sparsely hispid on the back, those of mature leaves apparently similar but narrower; petioles 45–60 cm. long, sparsely hirsute; blades 38–53 cm. long, cordate-reniform, shallowly palmately 9-lobed, firm chartaceous, above dark green, remotely hirsutulous, the lobes 8–10 cm. long, semicircular, the end of the midrib and one or more prominent lateral veins ending in short acuminations, the margin irregularly apiculate denticulate, the sinus broad V-shaped, below the surface pale green, prominently reticulate veined, subappressed hirsutulous on all the veins and veinlets; inflorescence probably axillary; bracts at base of inflorescence not seen; peduncle 15–20 cm. long, sparsely hirsute; inflorescence 37–64 cm. long, 10–15 cm. in diameter, lanceoloid, the axis ferrugineous tomentose, bractless, the lateral branches ascending, spiciform, tomentose towards base, glabrous towards tip; the principal lower bracts 15–20 mm. long, linear oblanceolate, the margin membranous; the flowers perfect, bright reddish, sessile; ovary ovoid truncate; calyx lobes 1–1.2 mm. long, oblong-lanceolate, the tip lacerate; petals 0.8–1 mm. long, obovate, cucullate, sparsely lacerate; the 2 anthers 1.5–1.7 mm. long, oval; the 2 stigmas 3 mm. long, filiform, densely puberulous throughout; drupes 3.5–4 mm. in diameter, globose, yellow; seeds 1.6–1.8 mm. long, 1.4–1.5 mm. wide, 1.1–1.2 mm. thick, broadly oval-obovoid, the apex emarginate, 4-angled, but somewhat compressed, two angles equal, the third well developed upwards, the fourth weak, the surface dull, stramineous.

Type: **Hawaii, Waipio, Upper Hamakua Ditch Trail,** 3,500 ft. alt., on moist cliff, Jan. 1, 1932, *H. St. John and E. Y. Hosaka 11,478.* B. P. Bishop Museum, Honolulu.

Collections studied, all from the island of Hawaii: Waipio Valley, Upper Hamakua Ditch Trail, face of pali at head of valley, alt. 1,300 m., Nov. 19, 1926, *L. H. MacDaniels 286;* Kohala Mts., Waimea, Sept. 7, 1911, *C. N. Forbes 488.H;* Kohala, Oct. 1931, *O. Degener*

8,183; Alakahi, Kawainui or Kawainui ditch or Kawainui Valley, July 12, 1909, *J. F. Rock, 129, and 4,374 or 4,375 or 4,376 or 4,382;* Waimea, Hawaii, June 1910. *J. F. Rock 8,432.*

The specimens with definite localities all came from the windward slope of the Kohala Mountains, a region of very wet, swampy forests, at the brink of the precipitous, deeply entrenched valleys. Waimea is the nearest town, with hotel and supply base. It is in open grasslands, not the sort of place where *Gunnera* grows. Doubtless Waimea was the base camp of the collectors, not the habitat and locality of the plant. Forest ranger Kawai reports another locality at the head of Honopue Gulch.

Rock's collection in 1909 bears confusing data on the four sheets examined. Alakahi and Kawainui are distinct valleys, both tributary to Waipio. They diverge sharply, so it is not evident how the locality could be in both valleys. Each of his sheets bears two numbers. His number 129 is perhaps a trip number, while the others are apparently serial numbers given to each sheet collected. Though bearing different numbers they are doubtless duplicate sheets. Degener's locality Kohala is also open to question. Kohala town, post office, and mill are in the lowland, remote from the area where *Gunnera* is known to grow. Perhaps this locality is to be taken as a general one, referring to the Kohala District or Mountains.

This new species is dedicated to Miss Alice Eastwood, Curator of Botany in the California Academy of Sciences. Her many decades of creative work have enriched the science of botany, and her friendliness and generous assistance have endeared her to all botanists who have consulted her.

5. **Gunnera kaalaensis** (Krajina) St. John, comb. nov.

(Plate 37, fig. e; plates 43, 44, 45)

Gunnera petaloidea Gaudichaud var. *kaalaensis* Krajina, Acta Botanica Bohemica 9:50, figs. F_3, B_2, Fl_2, P_2, A_2, 1930.

Giant herb; stem 1–3 m. tall, about 15 cm. in diameter, decumbent at base, the surface marked with raised, pale, corky leaf-scars, and above them numerous oval, raised craters; stipules 4–8 cm. long, lanceolate, scurfy on the back, membranous, strongly nerved; petioles 3–6 dm. long, at first densely hirsute, later sparsely so, with scattered dark tubercles; blades 20–50 cm. long, cordate reniform, shallowly palmately 7–9-lobed, firm chartaceous, above dark green, hirsute on primary and secondary veins or glabrate, below paler green, rough hirsute on the prominent, reticulate veins and veinlets, the lobes low undulate, shallow, rounded, 3–7 cm. long, the sinus broad U-shaped, the margin coarsely salient dentate; inflorescence axillary; bracts at base of peduncle reduced, about 2.5 cm. long, membranous; peduncle 7–12 cm. long, bractless, hirsute but soon glabrate; inflorescence 15–47 cm. long, 4–14 cm. in diameter, narrowly lanceoloid, the axis hirsute or glabrate, principal lower bracts 10–20 mm. long, linear-lanceolate, the margin membranous and not or but partly fimbriate ciliate, the lateral branches ascending spiciform, hirsute at base, glabrous towards tip; flowers perfect, sessile, greenish; ovary de-

pressed globose; calyx lobes 0.6–0.8 mm. long, rounded, lacerate; petals 1.3–1.8 mm. long, spatulate-obovate, cucullate, entire, obtuse, glabrous; the 2 anthers 1.1–1.3 mm. long, ovoid; the 2 stigmas about 2 mm. long, densely puberulous; drupes 2.8–3.1 mm. in diameter, globose, yellow; stone 1.8–1.9 mm. long, 1.4–1.6 mm. wide, 1.3–1.5 mm. thick, broadly oval-obovoid, the apex rounded or emarginate, with 4 prominent angles, the 2 lateral strongest and equal, the 3rd nearly as strong but diminishing at base, the 4th nearly as strong as the 3rd in the upper half, in the lower half nearly wanting, the surface yellowish brown, dull.

Type: "Oahu: Montes Waianae, in declivibus orientalibus sub summo montis Puu Kaala, 1150 m.s. m., legi 24. XI. 1929" [*V. Krajina* in Herb. Charles Univ., Prague, not seen].

Collections studied, all from Oahu, Waianae Mts., Mt. Kaala: Kaala Mts., *H. Mann and W. T. Brigham 626;* Mt. Kaala, Jan. 1920, *E. Bryan;* Mt. Kaala, elev. 3,200 ft., Feb. 11, 1928, *H. F. Bergman;* Puu Kaala, near summit, Waianaeuka, alt. 3,900 ft., wet stream bank, Nov. 24, 1929, *H. St. John 10,072;* Mt. Kaala, on moist upper slope by spring, elev. 1,100 ± m., April 21, 1929, *E. H. Bryan Jr. 707;* Mt. Kaala, Waianaeuka, 4,000 ft. elev., Feb. 2, 1930, *E. Y. Hosaka 139;* Schofield trail to Kaala, steep wet slope, elev. 3,300 ft., April 24, 1932, *E. P. Hume 547;* Puu Kaala, 3,600–3,800 ft., Waianaeuka, Jan. 8, 1933, *N. H. Krauss;* Kaala, eastern slope, at summit near spring, Sept. 25, 1938, *O. Degener, E. Ordonez and O. Selling 12,251.*

Koolau Range: Konahuanui, near summit, Oct. 19, 1930, *J. R. Coleman;* Puu Konahuanui, east face, n.e. of north peak, head of South Fork of Kahanaiki Stream, Kailua, 2,950 ft. alt., thicket on steep pali, June 21, 1942, *L. Eubank and A. D. Conger 131.* Puu Konahuanui, precipitous, small, hanging valley, east side of Koolau Divide, head of North Fork of Kahanaiki Stream, 2300 ft. alt., Kailua, May 9, 1943, *H. St. John 20,335.*

The localities for this species are discussed in the introduction.

Gunnera kaalaensis forms a narrow belt on the eastern side of Mt. Kaala. It is conspicuous and is collected by most botanists. The older collections, as that by Mann and Brigham in 1864–65 were probably made on the old trail that ascended from Waialua. The numerous recent collections are apparently all from the station on the trail from Schofield Barracks, above the Firebreak Trail in Waianaeuka. The collectors have stated the elevations all the way from 3,200 to 4,000 feet. Doubtless all of the collections on this trail were made at the base of the "pali" (precipice), or by the "spring" or stream above it at elevations between 3,500 and 3,700 ft. The plant does not seem to occur at the actual summit. On the earlier U. S. Government topographic map of 1917, the mountain was given the Hawaiian name, Puu Kaala, and an elevation of 4,030 ft. The recent one of 1938 calls the peak Mt. Kaala, and measures it as 4,025 ft. high.

The collection from Puu Kaala, St. John 10,072, shows on one sheet a young inflorescence which has the petals either entire or sparsely fimbriate. This fringing of the petals is not constant and has not been observed in any of the other numerous collections.

Krajina (p. 50) in separating this as var. *kaalaensis* included among the

characters that it had the blade shining above, while the blades of his var. *mauiensis* were not shining. In this present revision, this character is not substantiated, no diagnostic difference in the shiningness of the blade being noted between these two or any others of the Hawaiian species of *Gunnera*.

6. **Gunnera makahaensis** St. John, sp. nov.

(Plate 37, fig. b.)

Herba gigantea, caule 1.5 m. alta 15 cm. diametro, petiolis ad 7 dm. longis, laminis 20–37 cm. longis cordato-reniformibus arcte 7–9-lobatis chartaceis molle hirsutis in nerviis vel glabratis infra pallidioribus molle adpressi-hirsutis in nerviis reticulatis lobis sinuatis denticulatis mucronatis, pedunculo bracteoso, bracteis 15–20 mm. longis 4–5 mm. latis oblongo-spatulatis marginibus membranaceis bifimbriatis, pedunculo 5–7 cm. longo, inflorescentiis 15–60 cm. longis anguste lanceoloideis, axi tomentoso, bracteis inferioribus 15–35 mm. longis, ramulis spicatis, floribus viridescentibus sepalis 1–1.2 mm. longis late deltoideis profunde laceratis, petalis 1.9–2.2 mm. longis obovatis cucullatis marginibus erosis vel laceratis saepe acuminatis, antheris 1.6–2.2 mm. longis ovalibus, drupis ignotis.

Giant herb, 2 m. tall; stem about 1.5 m. tall and 15 cm. in diameter; stipules not seen; petioles about 7 dm. long, somewhat hirsute, soon glabrate, sparsely tuberculate; blades 20–37 cm. long, cordate-reniform, shallowly palmately 7–9-lobed, firm chartaceous, above dark green, sparsely soft hirsute on the veins or glabrate, below pale green, appressed soft hirsute on prominent veins and reticulate veinlets, the lobes 1.5–4 cm. long, shallowly sinuate semi-orbicular, the sinus broad and open U-shaped, the margin minutely salient denticulate and the principal dentations revolute mucronate; inflorescence probably axillary; bracts at base of peduncle 5–6 cm. long, oblanceolate, scurfy towards the tip and margin; peduncle when young clothed with numerous imbricate bracts which are 15–20 mm. long, 4–5 mm. wide, oblong spatulate, firm, glabrous, with a conspicuous broad membranous margin lacerate and ciliate fimbriate, the peduncle 5–7 cm. long; inflorescence 15–60 cm. long, 6–10 cm. in diameter, narrowly lanceoloid, the axis brown tomentose, the principal lower bracts 15–35 mm. long, oblong-linear, acute, firm, the conspicuous membranous margin lacerate and ciliate fimbriate, the lateral branches ascending, densely spiciform, tomentose except towards the glabrate tip; flowers perfect, sessile, greenish; ovary depressed globose; calyx lobes 1–1.2 mm. long, broadly deltoid, deeply lacerate; petals 1.9–2.2 mm. long, obovate cuculate, the margin erose to lacerate, often acuminate; the 2 anthers 1.6–2.2 mm. long, oval; the 2 stigmas 1.5–2 mm. long, filiform, densely puberulous; drupes unknown.

Type: **Oahu, Puu Kawiwi-Mt. Kaala ridge, Makaha-Waianae Kai, Waianae Mts.**, moist thicket in gulch, above pali [precipice], **3,500 ft. alt.**, March 31, 1935, *H. St. John 17,581.*

Collections studied: Oahu: Kaala Range, Makaha V[alley], Feb. 12–19, 1909, *C. N. Forbes;* Mt. Kaala, Waianae Mts., on wet wooded slope, el. 4,000 ft., (specimen brought by other students probably from the Makaha side), Feb. 2, 1930, *E. Y. Hosaka.*

The specimen preserved by Hosaka was given him by other students who pushed ahead and crossed the summit to the Makaha side. Hence, his generalized data and elevation of 4,000 feet are not to be considered accurate.

It is remarkable that there are two species on Mt. Kaala, *G. kaalaensis* being abundant on the wet windward slope, 300 to 500 feet below the summit. *G. makahaensis* is infrequent at about the same altitude on the drier leeward slope. Actually, the broad, flat summit is well watered and supports a swampy forest with a few boggy openings. *Gunnera* has not been found on the summit. The locality of this new species is along one of the streams draining from the wet summit down towards the dry Makaha Valley.

The islands Kauai, Molokai, and Hawaii each produce a single species. Maui bears two species, one on each of the isolated mountain masses of east Maui and west Maui. Oahu has one species in both mountain ranges with a considerable gap between the localities on Puu Konahuanui in the Koolau Range and Mt. Kaala in the Waianae Mts. It is known only on the eastern slopes of Mt. Kaala. Yet, on the drier, westward slope we find a second species. It is amply distinct from its close neighbor in characters of sepals, petals, anthers, bracts, leaf blade size, lobing, and toothing. It is the only Hawaiian species with the marginal teeth of the blade bearing definite revolute cartilaginous mucros. It has seldom been collected because of its scarcity and the long difficult ascent to the locality.

7. **Gunnera kauaiensis** Rock

(Plate 37, fig. a.)

Gunnera kauaiensis Rock, Occ. Pap. Bishop Mus. 9(5):3–4, pl. 1, 1930, Sept.
G. Dominii Krajina, Acta Botanica Bohemica 9: 50, 52, figs. F_1, B_1, I_1, Fl_1, P_1, A_1, 1930.

Giant herb, 1–3 m. tall; stem 1–1.3 m. tall, 10–15 cm. or more in thickness, fleshy, decumbent at base; stipules 4–5 cm. long, obovate, erose, pilose towards the margin, membranous, strongly nerved; petioles 3–6 dm. to "more than 1 meter" in length, at first brownish tomentose but soon glabrate except at base, purplish, with scattered pustules; blades 0.8–2 m. in diameter, suborbicular peltate about ⅓ way from one side, firm chartaceous, above dark green, sparsely hirsute to subglabrate, below pale green, hirsute on the raised reticulate veins and veinlets, the margin palmately 9–11-lobed, the lobes semiorbicular, acute, 5–10 cm. long, with a broad U-shaped sinus, the margin coarsely doubly dentate, the teeth 2–4 mm. long; inflorescence probably axillary; basal bracts not seen; peduncle 6–10 or more cm. in length, brownish hirsute; inflorescence 3–6 dm. long, ("1 meter or more long," fide Rock), 8–17 cm. in diameter, dense, lanceoloid, the axis densely brownish hirsute, at length subglabrate, lower primary bracts 15–18 mm. long, oblong-lanceolate to spatulate, glabrous, the margin scarious, the lateral branches ascending, spiciform, hirsute at base, glabrate at tip; flowers perfect; ovary depressed globose; calyx lobes 0.3–1 mm. long, deltoid, the margin thin, lacerate; petals 1.1–1.3 mm. long, obovate cucullate, the margin ciliate or lacerate; the 2 anthers 1.9–2.1 mm. long, oval; the 2 stigmas 1.5–2 mm. long, filiform, densely puber-

ulous; drupes 3–4 mm. in diameter, globose, red to purplish; stone 1.9 mm. long, 1.6 mm. wide, 1.4 mm. thick, oval, somewhat compressed, the apex emarginate, conspicuously 3-angled, the 2 lateral angles equal, acute, the 3rd angle prominent and acute in the upper half, wanting below, the 4th angle undeveloped, the surface stramineous, dull.

Type: "Kauai, along the stream beds of Kaluiti and Kailiili, just below the summit of Waialeale, elevation 4800 to 5000 feet, September 22, 1909 (fruiting), J. F. Rock no. 5053. Type B. P. Bishop Mus." On one or more of the five isotypic sheets are found the numbers 5,050, 5,053, and 5,058. These are apparently individual numbers given by the collector to each sheet. Later he selected the number 5,053 to stand for the collection. They all bear also the number 129 which perhaps may be a trip number, though it duplicates the one for the collection from Hawaii in the same year. Rock's three series of numbers on his collections are not well understood by the botanists of Honolulu.

Collections studied, all from Kauai: Kahili summit, Aug. 1909, *C. N. Forbes;* Kilohana Outlook above Waimiha, Waimea Drainage Basin, West Side, July 3 to Aug. 18, 1917, *C. N. Forbes 903.K;* Kilohana lookout, N. W. end Alakai Swamp, Na Pali-Kona forest reserve, wet steep slope, el. 4,023 ft., Dec. 27, 1930, *H. St. John et al, 10,788;* without locality, Oct. 1916, *J. F. Rock.*

Rock (p. 3) described the "Panicle terminal." Neither his specimens nor any others of those available in Honolulu show an attached inflorescence. All of the other Hawaiian species have their inflorescences developing near the stem tip, but truly axillary, and it seems probable that this one does too. The inflorescence is not a true panicle, rather it has an erect common axis bearing numerous ascending, unbranched spikes.

This is the most distinct of the Hawaiian species, differing markedly from all the others. It alone has orbicular, peltate blades and drupes that are red to purplish. It also differs in the size and structure of the flowers and fruits.

As indicated in the introduction, it is still an open question as to which of the two specific names of this species is the earlier. *G. kauaiensis* Rock was published in September 1930. *G. Dominii* Krajina was published in the same year, 1930 (Acta Botanica Bohemica 9:50, 52, figs., 1930). Previous requests for the exact date of publication, sent to Prague have been unanswered. Now we acknowledge with thanks the assistance of the librarians of the Gray Herbarium, the British Museum of Natural History, and the Director of the Kew Gardens. It is not known whether or not the several articles in volume 9, Acta Botanica Bohemica were issued separately at various dates, or not. In any case, volume 9 was commonly distributed as a single bound volume, and the copies were received by the three institutions listed, Gray Herbarium on Oct. 25, 1932, Kew on March 6, 1933, and British Museum on April 1, 1936, but these dates of receipt are so late as to be of no help. Krajina lists as *G. petaloidea* var. *mauiensis* his own specimen collected on Maui on April 15, 1930. His manuscript must have been written later than April, and in all probability after he returned to Prague. From this it can be deduced only that his

paper was not published early in 1930. The first paper in vol. 9 was by the editor, Karel Domin, "A new species of *Psittacanthus* from Dominica," which paper was not listed in the Botanisches Centralblatt until July 6, 1933. The succeeding volume 10 of Acta Botanica Bohemica contained a chronological bibliography of Dr. Karel Domin's publications. Two of them were published in volume 9, and they are listed in the bibliography as appearing in 1930. In one of these papers, page 256, Domin cites a plant specimen collected on Sept. 20, 1930, which would imply that his paper was printed late in the year 1930. Volume 12 (1934) of the Prague journal Preslia is devoted almost entirely to bibliographic notes, and it lists Krajina's *Gunnera* paper as published in 1930, stating only the year. It is not known that this vol. 9 was issued only in complete volume form, and the exact date of Krajina's publication is still unknown. Since Rock's publication was dated Sept. 1930, it is tentatively accepted as the prior publication.

PLATES

PLATE 37

Margin of terminal and one lateral lobe of blade of the Hawaiian species of *Gunnera*. a, *G. kauaiensis;* b, *G. makahaensis;* c, *G. kaalaensis;* d, *G. petaloïdea;* e, *G. molokaiensis;* f, *G. Eastwoodae;* g, *mauiensis.*

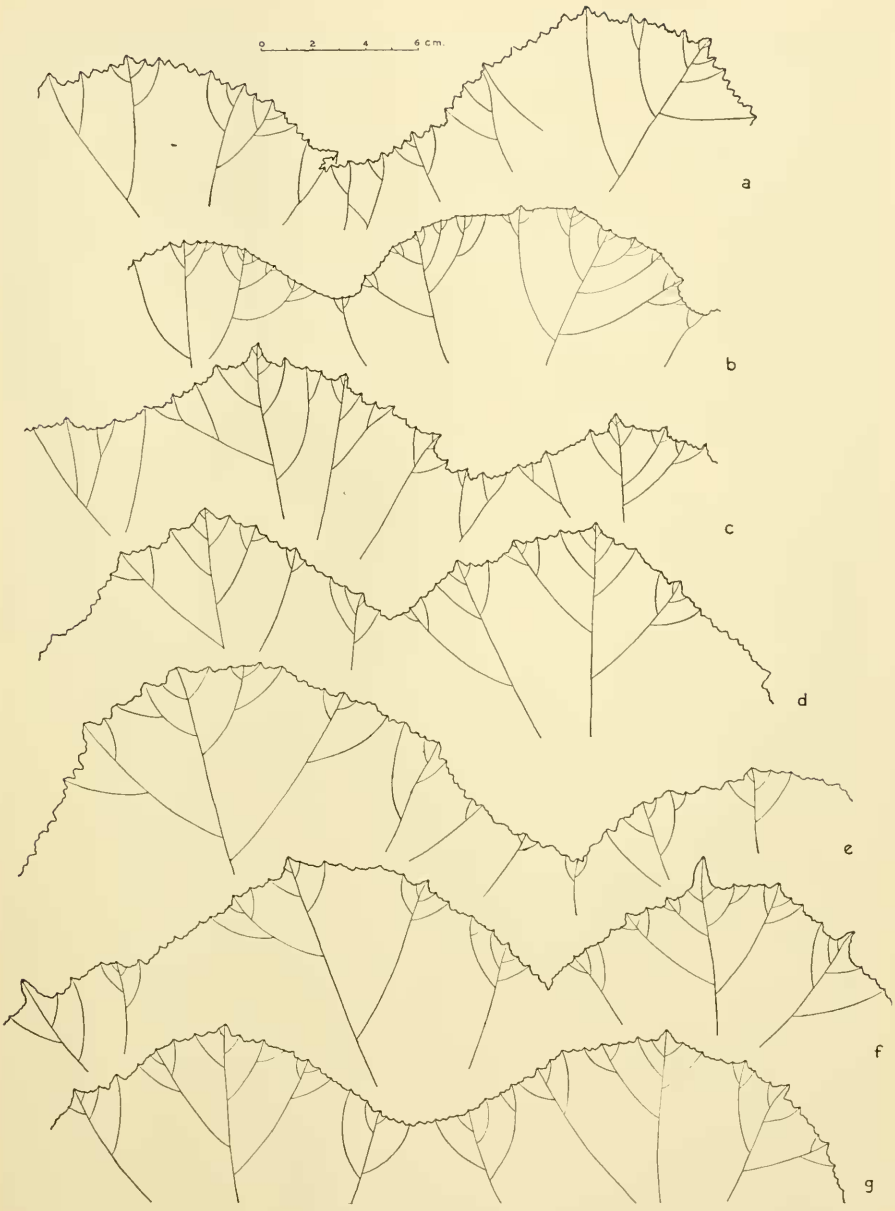

0 2 4 6 cm.
a
b
c
d
e
f
g

PLATE 38

Gunnera petaloïdea Gaudichaud, type in Herb. Museum d'Histoire Naturelle, Paris.

Photo by H. St. John.

PLATE 39

Gunnera petaloïdea Gaud., at head of Kahana Valley, 3,800 ft. alt., west Maui, October, 1942.

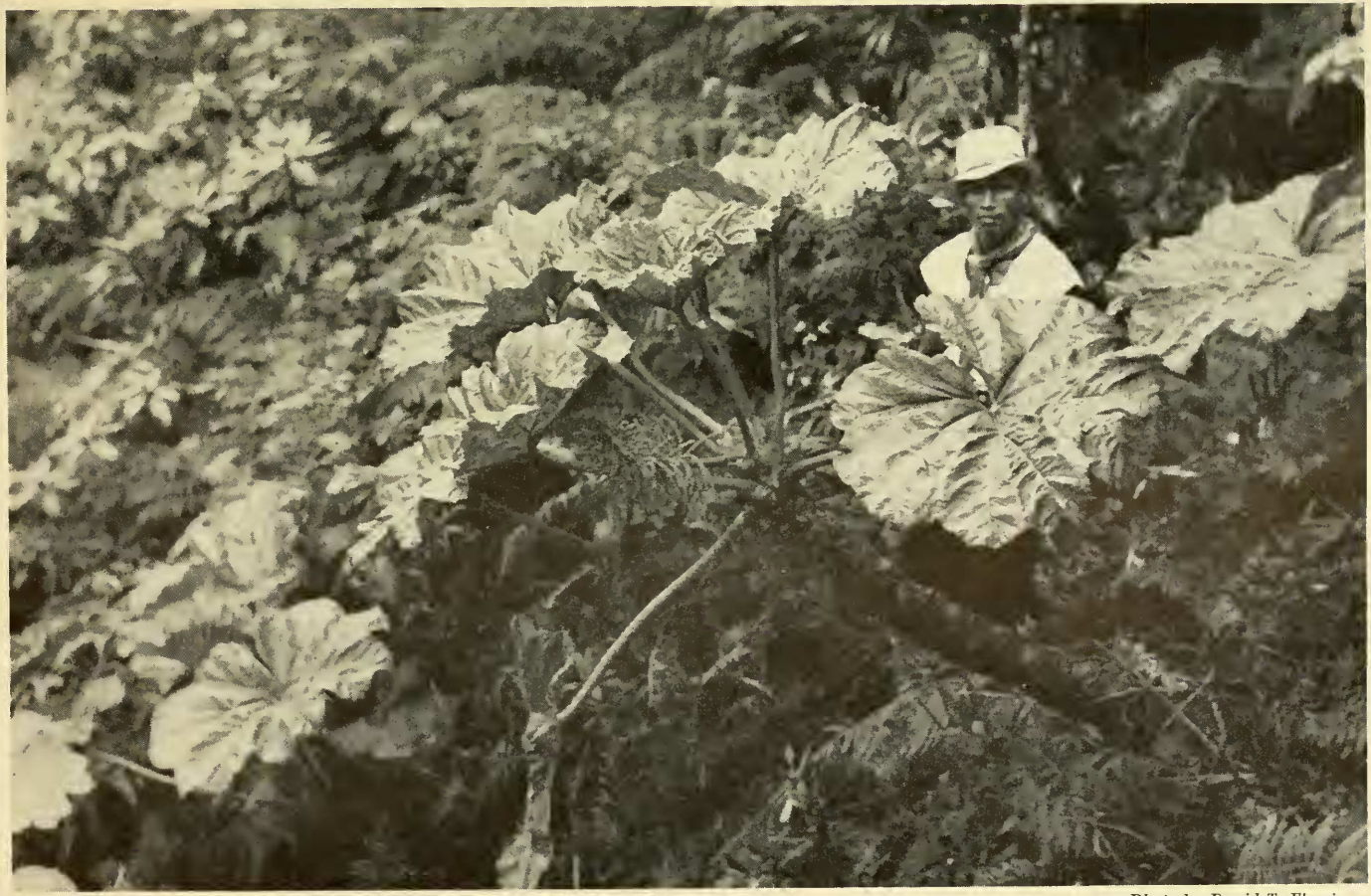


Photo by David T. Fleming.

PLATE 40

Gunnera mauiensis (Krajina) St. John, Kula Pipe Line, bank of Waikamoi Stream, 4,250 ft. alt., east Maui, with figure of Royal N. Chapman.

PLATE 41

Gunnera mauiensis (Krajina) St. John, Kula Pipe Line, bank of Waikamoi Stream, 4,250 ft. alt., east Maui, with figure of Worth Aiken, 1925.

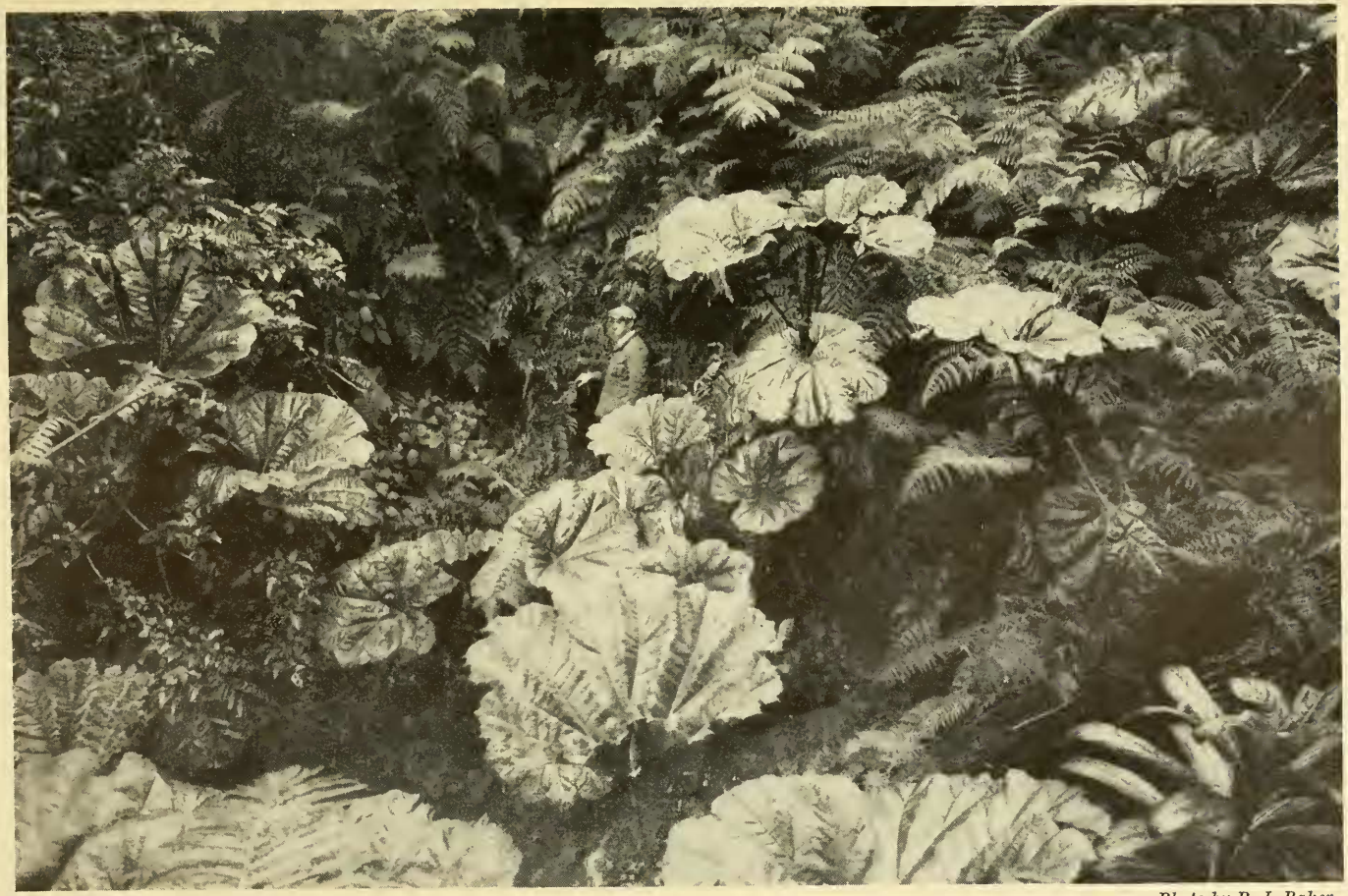


Photo by R. J. Baker.

PLATE 42

Gunnera Eastwoodae St. John, type specimen, Upper Hamakua Ditch Trail, 3,500 ft. alt., Waipio, Hawaii, January 1, 1932.

Photo by H. St. John.

PLATE 43

Gunnera kaalaensis (Krajina) St. John, Mt. Kaala, Waianaeuka, 3,500 ft. alt., Oahu, with from left to right, figures (in upper right) of H. Pope and W. B. Storey.

Photo by Willis T. Pope.

PLATE 44

Gunnera kaalaensis (Krajina) St. John, Mt. Kaala, Waianaeuka, 3,500 ft. alt., Oahu, with, from left to right, figures (in foreground) of H. Pope and W. B. Storey.

Photo by Willis T. Pope.

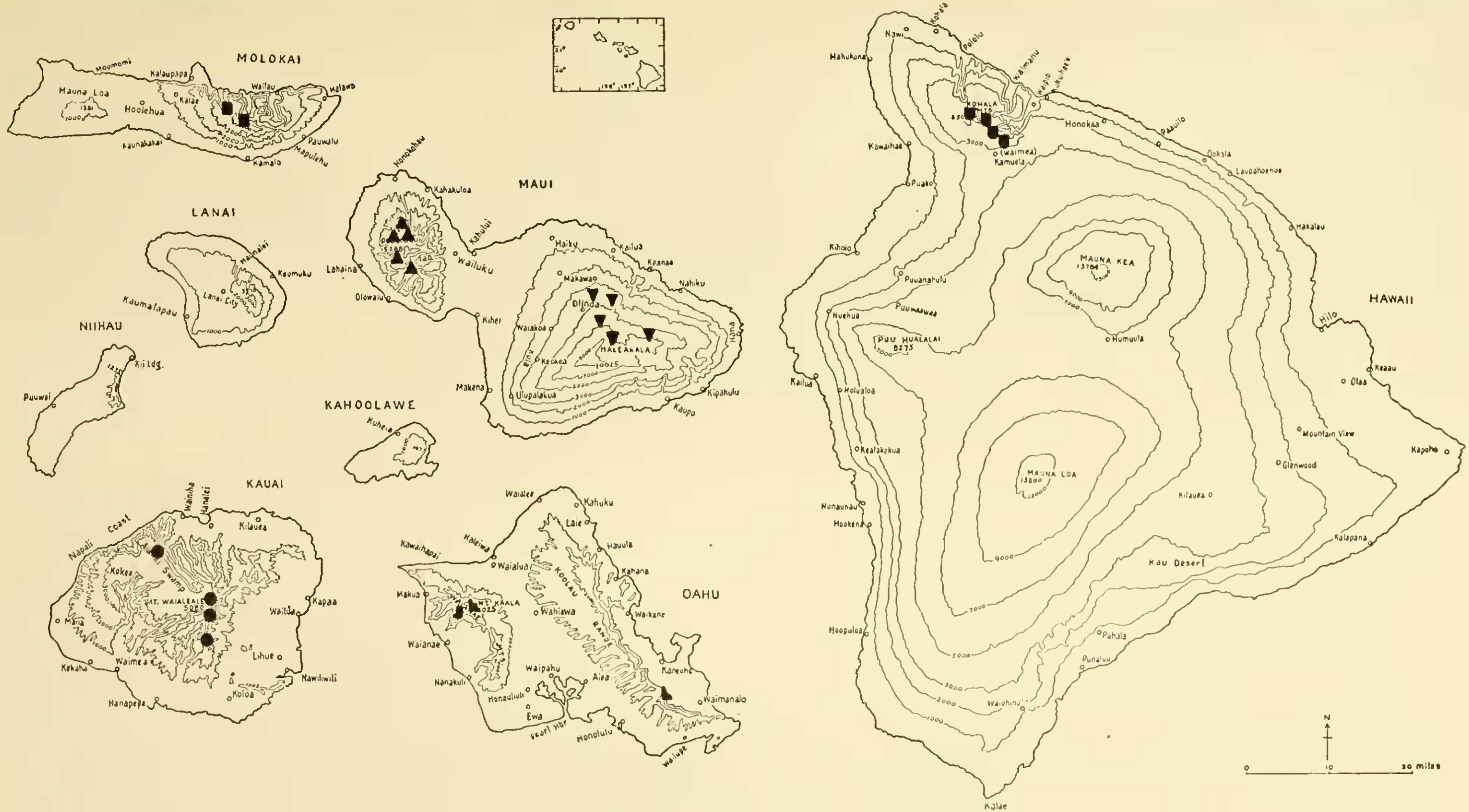
PLATE 45

Gunnera kaalaensis (Krajina) St. John, Mt. Kaala, Waianaeuka, 3,500 ft. alt., Oahu.

Photo by Willis T. Pope.

PLATE 46

Distribution of *Gunnera* in the Hawaiian Islands.
Square: *Gunnera molokaiensis;* Erect Triangle: *G. petaloïdea;* Inverted Triangle: *G. mauiensis;* Shield: *G. Eastwoodae;* Circle: *G. kauaiensis;* J: *G. makahaensis;* L: *G. kaalaensis.*


MOLOKAI
LANAI
NIHAU
MAUI
KAHOOLAWE
KAUAI
OAHU
HAWAII
MAUNA KEA
MAUNA LOA
PUU HUALALAI
HALEAKALA
KOOLAU RANGE
Kau Desert
Napali Coast
Alakai Swamp
MT. WAIALEALE
MT. KAALA
KOHALA
Mauna Loa
Hoolehua
Kalaupapa
Kalae
Wailau
Halawa
Kaunakakai
Kamalo
Pauwalu
Mapulehu
Moomomi
Lanai City
Keomuku
Kaumalapau
Kii Ldg.
Puuwai
Honokohau
Kahakuloa
Wailuku
Kahului
Lahaina
Olowalu
Kihei
Makena
Haiku
Kailua
Keanae
Nahiku
Hana
Kipahulu
Kaupo
Makawao
Olinda
Waiakoa
Kula
Keokea
Ulupalakua
Kuheia
Waiahea
Kahuku
Laie
Hauula
Kahana
Haleiwa
Kawaihapai
Waialua
Makua
Wahiawa
Waianae
Nanakuli
Honouliuli
Ewa
Pearl Hbr
Waipahu
Aiea
Kaneohe
Waikane
Waimanalo
Honolulu
Waluye
Wainiha
Hanalei
Kilauea
Kokee
Kapaa
Wailua
Lihue
Nawiliwili
Koloa
Hanapepe
Waimea
Kekaha
Mana
Nawi
Kohala
Pololu
Waimanu
Waipio
Kukuihaele
Mahukona
Kawaihae
Puako
Kiholo
Honokaa
Paauilo
Ookala
Laupahoehoe
Hakalau
Hilo
Keaau
Olaa
Mountain View
Glenwood
Kapoho
Kalapana
Kilauea
Kamuela
(Waimea)
Puuanahulu
Puuwaawaa
Huehue
Kailua
Holualoa
Kealakekua
Honaunau
Hookena
Hoopuloa
Humuula
Pahala
Punaluu
Waiohinu
Kalae
20 miles
N